my design. The instrument, so far as I have hitherto tried it, fully answers my expectations.

A plan somewhat similar to Mr. Bidder's for using a "ghost" of the wires instead of the wires themselves, but applied to a meridional instrument, is described by M. Karl v. Littrow, in the *Proceedings of the Academy of Sciences*, Vienna, Vol. XX., for 1856. M. Littrow uses intercepted wires in the same way as in Mr. Bidder's contrivance.—Ed.

On the Fixing of Spider-lines in Collimators and Transit Telescopes.

By Capt. John Herschel, R.E.

Some time ago I had occasion to replace some broken wires in the diaphragm of a transit telescope. As it is an operation which every practical astronomer ought to be able to perform for himself—more especially when on foreign duty—and as there *are* difficulties about it which may be lessened by reading an account of a similar operation, of a rather unusual kind, as actually performed, I will endeavour to recall what I can recollect of it.

I may preface this particular account with one or two general remarks upon the subject.

The occasions upon which skill in wiring diaphragms may be brought into play with advantage are so numerous, that it is well to take advantage of every opportunity to put whatever may exist into practice, with a view to prepare for cases of emergency. It does not always happen that the wires of a collimator, for instance, are adapted, in thickness and angle, to the use to which they are to be put—in which case it is very convenient to be able to replace them readily. On foreign service, too, the liability to disfigurement or fracture is much increased; and if confidence has been acquired, a few hours' work at the right time will save much annoyance later. The case I am about to describe was so prefaced, fortunately, by many lesser experiences.

My next remark has reference to ways and means. There are often many ways of doing the same thing, and these often depend on the means at hand. It will be seen that mine were not of an out-of-the-way kind. Such as they were, they sufficed, but possibly others would have served equally well. Some implements, however, are almost essential; for instance, a camel's hair or sable brush—better still, two or three; a lump of beeswax; a few corks, and a few carpentering tools and materials are also useful. Some sort of varnish, too, is necessary—I always use shellac—and some spirits of wine.

The diaphragm upon which I operated was one cut for 25 wires in 5 tallies of 5—the whole occupying about one-third of an inch—on the longer sides of a rectangular plate or frame

about $1\frac{3}{4}$ inch $\times 3\frac{1}{2}$ inches. The occasion arose, let us say, after the visit of some obnoxious creature. Whatever it was, the set was damaged, and I concluded to try my hand at a new one.

Now arises the question whether it is better to replace individual wires or the whole set. Considering the relative difficulties —upon which I will not now waste space—I caution anyone against partial reconstruction—especially in delicate cases. At any rate, I decided the question by pushing a finger through the frame.

The next step was to clean the frame. This is very important. Unless all the old fibres and the varnish are removed from the grooves, there will be trouble afterwards. Here the brush and spirit, and a little patience and care, come into play. A cloth may also be applied without fear. It is not an easy thing to scratch brass so deeply with cotton fibre as to form false grooves. Of course the less sand there is in the cloth the better; but there may be a good deal of misplaced tenderness in handling a wire-frame after its wires are broken or condemned.

We proceed now to get the fibre. A good deal might be said about spiders with reference to the fitness of their silk. I do not know enough to speak positively. But I *believe* that very generally what is to all appearance a simple thread is really a bundle of parallel threads. Whether it is possible to get a simple fibre of any considerable length and of sufficient thickness, I doubt. As a fact I am pretty sure that my 25 wires, when finished, were a series of equal strands of fibres—although in appearance as perfect a set as I have ever seen—infinitely superior, I need hardly say, to those which were now beyond the reach of comparison.

The size, uniformity, and quantity of web required are all matters for consideration. The size must be found by trial. Different species of spiders give very different qualities, and in very different degrees. For the sake of uniformity it is very desirable to secure an ample supply from the same source. The quantity will depend on the method of using it.

Having selected my spider, I proceeded to spin from him thus. I had prepared a pane of window-glass with a rod at the back, attached by lumps of wax, to act as a spindle. Having coaxed the spider to attach his web to this, and having shaken him off, I allowed him *to alight*, and then reeled off just fast enough to prevent him from attaching again. I cannot enter into his feelings sufficiently to explain the why and the wherefore, but after many trials I found this the only safe way to get a *long uniform web*, and in this way I generally *could* get an unbroken thread of 30 or 40 feet without stopping. It will be found that very rapid reeling is necessary, and this the 8-inch window-pane spinning on its temporary axle sufficiently provides for. It is hardly necessary to say that, except in a peculiar light, the whole operation is effected without *seeing* the thread. The attitude of the spider alone betrays the connexion; and when, by watching the

creature, the rupture of this connexion becomes known, the direction of the axle must be immediately changed, so that the last two or three turns of the web may cross the glass at an angle—otherwise great difficulty will be experienced in finding the end.

It may seem absurd to wind off so much when only a few inches are wanted. I reply that I wanted 12 or 15 feet, and when my work was done actually had at least 10 feet of continuous thread employed upon the diaphragm.

The next operation introduces a device which is the principal feature in my plan. As yet the thread is wound anyhow. I want to wind it afresh in an orderly manner. For this purpose I make a little hook of light wire, which is to hang on the web as a man hangs with two outstretched arms from a horizontal bar. It is intended to run freely along the web, or the web through it, without risk of the latter twisting upon itself. I will call this the *stirrup*.

The end of the web being found, and one turn unwound, the stirrup is hung on to the slack, and the end attached by a piece of wax to the glass. By this time the need of two Y supports for the spindle will be found, if not already provided. When placed upon them the web will form a swing as it were for the stirrup, and as the spindle is turned the fibre will be wound up on one side as fast as it is unwound at the other, and this winding can be directed by tilting, to any required extent. By this means the whole can be passed under review and re-wound, backwards and forwards, with composure and certainty.

The next step was to transfer the web to the diaphragm. For this purpose I attached a spindle lengthwise at the back of that too, and supported it alongside the other. Then, having transferred one end of the web to the brass frame, the stirrup swinging between, I was able to wind off upon it as much as was wanted, viz. from 30 to 40 turns of the frame, and then, having broken it off from the glass, attached the other end also to the diaphragm at the other end of the rectangle, the stirrup still swinging in the light below. The arranging process was now repeated preliminary to a final re-winding upon the grooves.

This winding and re-winding has the effect of insuring the detection of flaws and of equalising the tension.

The re-winding upon the grooves requires steady supports and a slight tilting arrangement; and the placing of every successive convolution in its place, when the face of the diaphragm is vertical, must be done with the help of a lens held in an appropriate support in front of it.

Ultimately the whole of the 25 convolutions having been thus arranged as nearly as practicable in or close to their respective grooves, the outer edges of the diaphragm were streaked with varnish; and when dry the superfluous fibres at the back cut off, by running a knife-edge along the angles of the frame.

At this stage a final examination of the wires might have

led, but did not, to the substitution of one or more from the unused stock. The perfection of the method is such that it can hardly happen that any such substitution would be necessary.

The last step is the most troublesome. Every fibre has now to be lodged in its groove. This may be done approximately first—always with a brush—and a very weak varnish applied. The obstinate ones can then be manipulated and coaxed with greater freedom. And, lastly, a stronger varnish fixes them all.

I do not know how these things are done by the professional opticians. But I do know that, both in this case and in a second, the intervals between the wires were less unequal after the operation than before. The improvement in the uniformity of the wires as to thickness might be a matter of opinion, but the greater regularity is on record, numerically, as a fact. I infer from this that the method is surer, if not easier.

Observations of the Total Solar Eclipse of April 16, 1874, *at Klipfontein, Namaqualand, South Africa.*

By E. J. Stone, Esq.

(*Extract from a Letter to the Astronomer Royal.*)

I observed the eclipse from Klipfontein, a station about 3,000 feet above the sea-level. The sky was perfectly clear, and no finer day could have been wished for. I had borrowed a four-inch telescope, mounted as an altazimuth, from Mr. H. Solomon. My spectroscope was one with two dense flint prisms of 60°; a fair amount of dispersion, therefore, being thus obtained. My great difficulty was to attach the spectroscope firmly to the telescope. Ultimately I was obliged to give up all idea of using the prism of comparison, and to fix the tubes together by wrappers of wash-leather. In this way I secured a very firm connexion between the spectroscope and telescope. I placed two wires in the focus of the telescope of the spectroscope for estimations, and determined to measure only the position of one line in the Corona, the micrometer wire being left untouched until the reappearance of the Fraünhofer lines, when the differences between the line measured and these lines could easily be fixed.

The slit was set as wide as would allow of a clear and distinct view of the Fraünhofer lines. This I did because I expected to find the spectrum of the Corona faint, but was anxious to see whether the Fraünhofer lines were present or not in the spectrum of the Corona. I could not change the width of the slit without taking the spectroscope off the telescope, on account of the way in which I had been compelled to join them together.

During the partial eclipse I most carefully examined the speculum near the Moon's edge, by comparing it with the spectrum away from the Moon's edge, to see whether any fresh